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L12: Entry 70 of 153 File: USPT

DOCUMENT-IDENTIFIER: US 5931877 A
TITLE: Advanced maintenance system for aircraft and military weapons

Abstract Text (1):
An equipment maintenance system (10) comprising a central data storage warehouse (16) for electronically storing technical information and for providing on-line technical assistance for repairing the equipment. A data transceiver (12) transmits data to and receives data from the central data storage warehouse (16). A communications link (22, 26, 28, 30) between the central data storage warehouse (16) and the wireless data transceiver enables accessing of the technical information from the central data storage warehouse (16) by the data transceiver (12). Test means (40) identifies failed system components and minimizes occurrences of false BIT flags, unnecessary system maintenance and removal of operational system components. The maintenance system finds particular utility when implemented in conjunction with a fleet of transport vehicles, such as aircraft (14), or with military weapon systems (14).

Brief Summary Text (3):
The present invention relates generally to aircraft and military weapon maintenance and repair, and in particular to an advanced aircraft/weapon maintenance system that provides remote trouble-shooting and technical data access capabilities to technicians through a wireless link between a handheld point-of-maintenance transceiver and a central diagnostics center, thereby minimizing maintenance and repair time, costs and requisite paper reference materials.

Brief Summary Text (5):
A large number of currently deployed military aircraft and weapons, such as the F-15E aircraft, were designed in the late 1970's and early 1980's with built-in test (BIT) logic that indicates to a system operator when a system component has failed or requires maintenance. This BIT logic which is typically designed into a system and implemented on a system level through both hardware and software, reports system failures or malfunctions due to failure of one or more system components which the logic is designed to detect. These failures or malfunctions are made known to the system operator, such as an F-15 pilot, on a cockpit display through a BIT flag identifying the specific failure or malfunction.

Brief Summary Text (6):
In operation, the system will generate significant amount of information for analysis by the BIT logic. The BIT logic then automatically performs a system-wide nodal analysis and can generate equipment maintenance orders usually signalled by generation of a BIT flag, based upon a combination of BIT data and system operator observations. Therefore, a component identified may be repaired or replaced before the aircraft or weapon fails or malfunctions on the front line.

Brief Summary Text (7):
However, conventional BIT logic often generates maintenance orders for components when the components are in fact fully operational. As a result, fully operational components will often be pulled and replaced. Therefore, overall weapon/aircraft maintenance costs are increased due to the performance of such unnecessary maintenance procedures. The removal of fully operational components also increases the number of aircraft or weapons temporarily out of commission and increases the number of maintenance technicians required to service the equipment.

Brief Summary Text (8):
In addition, once the BIT logic indicates that an aircraft or weapon requires repair and maintenance through generation of a BIT flag, technicians must be dispatched to the remotely located weapon, or intermediate hub repair points must be set up for servicing of these remotely located aircraft or weapons. Due to the ever increasing complexity of the electronics implemented in such systems, the technicians must exhibit a high level of training and have a high level of associated skill to repair the associated equipment. In addition, the technicians must have technical reference materials available to correctly locate and identify a flagged problem. For instance, it is estimated that the F-15 aircraft has an associated 16,000 pounds of associated technical data, paper reference materials, parts and repairs manuals, and other related reference materials. As updated technical data is published at regular periodic intervals, it is difficult at best for even the most highly skilled and trained technician to keep abreast of the most up-to-date information associated with each weapons system. Further, as such repair and component replacement must often be performed at locations remote from a central repair facility, the associated reference materials are often not readily available to the technicians when and where the materials are most needed. As is often the case, even updated reference materials are often months, or years, behind the most recently-implemented equipment.

Brief Summary Text (11):
Therefore, it would be desirable to provide a maintenance system for such aircraft and military weapons systems that would minimize the number of false pulls of still operative system components. It would also be desirable to provide a maintenance system that would eliminate the need for intermediate, or hub, repair facilities implemented remotely from a central station and that would virtually eliminate the associated paper-based technical reference materials. This would minimize the associated time and cost and maximize accuracy and efficiency of system repair and maintenance operations.

Brief Summary Text (13):
In accordance with the teachings of the present invention, an advanced maintenance system is provided that utilizes existing system hardware and software, along with on-line technical expertise, to substantially enhance maintenance and repair of equipment such as aircraft and military weapons to reduce and/or eliminate removal of fully functional system components. The maintenance system of the present invention utilizes wireless transceivers or a combination of high speed land lines and wireless transceivers, in communication with a central data warehouse. These wireless transceivers eliminate the volumes of technical manuals and maintenance information typically associated with equipment repair facilities and reduce requisite parts inventories at repair depots. The maintenance system of the present invention also initiates and logs repair actions and work orders, thereby eliminating the need for paper tracking of repairs. The system also provides historical maintenance data for a particular aircraft or weapon. The maintenance system of the present invention thereby provides an information management solution to a problem that has characteristically been treated as hardware-based.

Detailed Description Text (3):
Referring to the drawings, FIG. 1 illustrates an aircraft/weapon maintenance system according to a preferred embodiment of the present invention generally at 10. The aircraft/weapon maintenance system of the present invention represents a new way of approaching the test and diagnostics of both aircraft, or other transport craft such as tanks or ships, and military weapons, starting at the system level or the serial numbered assembly and embracing all higher test levels. The weapon system of the present invention utilizes commercial, off-the-shelf hardware and information retrieval systems, existing technical and maintenance information, and a software-implemented enhancement for existing system-level BIT logic, integrated into a single system. The weapon system of the present invention achieves dramatic improvements in fault-detection and fault-isolation accuracy, with attendant reductions in false removals of fully functional components from aircraft, military weapons, or other systems requiring maintenance at locations remote from a central maintenance facility. These results enable substantial reductions in overall aircraft/weapon logistics footprints, reduce spare component requirements, and provide reduced depot (permanently installed facility dedicated to high volume repair of units, such as F-ISEs, requiring special engineering support and facilities) and

(I-Level intermediate repair point deployable with forces at a permanent operating location) workloads.

Detailed Description Text (4):
The key components of the maintenance system of the present invention are shown in FIG. 1. A portable maintenance aid (PMA) 12 is provided for use by a repair technician. The PMA may be used along with conventional aircraft/weapon BIT logic, to remotely troubleshoot an aircraft/weapon 14, shown with an associated display 15, for component fault isolation. While reference will be made throughout to an aircraft or weapon, it should be understood that the system represented at 14 may also be any other type of system, such as tanks, ships, or other vehicles, requiring periodic maintenance or repair. The PMA or, optionally, a conventional desktop computer, also provides on-line access of a central data warehouse 16 for real-time communications and transmittal of technical information and data, plus initialization and population of repair/work orders.

Detailed Description Text (6):
The PMA 12 is a key element of the maintenance system of the present invention, as it delivers critical maintenance-related data in real time to and from the point of use. The PMA is preferably a commercially available hand-held computer such as the units manufactured by Paravant Computer Systems, Allied Signal Aerospace, computing Devices International and SAIC. The PMA preferably has a nominal weight of 5 to 7 pounds, and includes the associated radio link 22. The PMA is capable of providing a technician with maintenance procedures, illustrations and parts lists downloaded in real time from the central data warehouse 16 to aid the technician in repair/maintenance work and eliminate paper reference materials. Additionally, the PMA of the present invention automatically generates a network repair order subsequent to isolation of the problem at the aircraft or weapon.

Detailed Description Text (7):
The PMA 12 is implemented to provide automated download of BIT data from an aircraft or weapon bus if the weapon or aircraft is appropriately configured. For example, in the U.S. Department Of Defense environment, a convenient means to extract a significant amount of BIT and related aircraft performance parameters presently exists on aircraft such as the F-15, F-18, and F-16. A Data Transfer Module (DTM) or Data Transfer cartridge (DTC) exists on these aircraft to record test and performance parameters during each aircraft sortie or mission. The DTM or DTC may be removed from the aircraft and downloaded off-line (on the F-15 and F-18 this is known as a Computerized Fault Reporting System or CFRS) during the official pilot debrief. Similarly, on aircraft such as the Boeing 777, there are 5 access ports to the aircraft bus are present for downloading of BIT-related information to the PMA. The maintenance system 10 of the present invention can automate this process and provide direct interface to the central data warehouse 16.

Detailed Description Text (8):
The base file server 24 is a control and interface unit for storing data requested by the PMA and the central data warehouse. The file server also functions as a data re-entry point for repopulation of new data at the maintenance database 16. Blocks of information may also be downloaded to the file server for local non-real-time access as needed. The file server 24 is hooked to the commercial satellite terminal 26. The satellite terminal 26 enables real-time communication via satellite between the PMA 12 and the central data warehouse 16.

Detailed Description Text (9):
The satellite system 28 is of the type that is commercially available and which utilizes low-cost, commercial ground stations incorporating Very Small Aperture Terminals (VSAT) with 1 to 2 meter antennas, such as the satellite terminal 26. The system 28 provides the system 10 of the present invention with real-time, on-line satellite communications capability. Thus, one main operating terminal located at the data warehouse 16 or at the file server 24 and utilized for each maintenance activity can communicate with a plurality of PMAs in use via the FM ground net radio link 22. Requests for relevant portions of current technical orders or technical manuals for the particular aircraft or weapon under analysis are made by a technician at the PMA 12 through the VSAT, which preferably has a narrow-band (128 Kbytes/sec) uplink capability. The request is then downloaded via wideband downlink (512 kb/sec) to the

central data warehouse 16. It is contemplated that these data rates will increase as the associated technology matures. This download eliminates the need to distribute and control the electronic format. In a non-maintenance environment, such as status tracking, trend analysis, etc., PC-based terminals may also be interconnected to the satellite system to provide real-time communications capability to the central data warehouse.

Detailed Description Text (13):
Reference will now be made to the central data warehouse 16. Instructions from the central data warehouse 16 are provided via the satellite system 28 directly to the technician performing tests on the aircraft or weapon 14, along with illustrations and other pertinent information. Expert help from experienced technicians is also available at the central data warehouse facility. Since one location serves all users, it is conceivable that a 24-hour staff of experts in each aircraft or weapon system be available full time to assist in resolving difficult maintenance problems.

Detailed Description Text (14):
The interactive electronic technical manual (IETM) and library database 18 is implemented at the central data warehouse 16. This IETM library database may be accessed by PMAs in remote operating locations via the radio link 22 and satellite system 28. The technical library is created from any source documentation, technical manuals, Logistics Support Analysis Record (LSAR), parts illustration, or like record. Upon receiving a request for information from a particular technical manual, the central data warehouse 16 automatically pulls the correct repair procedure, including all recent revisions, based upon the transmitted symptoms and diagnosed fault at the aircraft or weapon 14. This information is then sent to the requesting PMA. Subsequently, the PMA displays correct diagrams/chromatics/part listings and interchangeability to the technician. In addition, the technical manual database 18 may direct a guided probe and perform additional tests and observations in order to unambiguously isolate the fault occurring at the aircraft or weapon. Such an electronic technical manual database thereby eliminates the need to distribute paper or CD ROM copies of any technical orders or manuals to field technicians and eliminates the need for on-site configuration management of these operating manuals. It should also be appreciated that the central data warehouse 16 will also accommodate standard technical manuals in raster or vector scan format.

Detailed Description Text (15):
Additionally, information contained in the real-time technical manual and IETM library database 18 is automatically provided to the technician. The central data warehouse 16 contains all technical order information in either IETM or raster/vector format, in the technical database 18. Instead of distributing a full set of technical orders or technical manuals to intermediate hubs located near deployed aircraft and/or weapons where maintenance is performed, technical order/technical maintenance manual (TO/TM) data is maintained only at the central data warehouse, which is implemented via distributed database methodology, and downloaded only upon demand to the PMA. This eliminates the need to continuously update, print, distribute, and maintain paper copies of TO/TMs, and the need to cross-reference by Serial Number (SERNO) and configuration break-in-point.

Detailed Description Text (16):
As soon as a TO/TM change is approved, it is immediately available to all field technicians. Maintenance procedures, illustrations from an illustrated parts breakdown reference, parts listings, interchangeability data, and provision-type data are all available real-time, on-line, to the technician at the flight line or the point of maintenance. Alternatively, the information may be downloaded periodically to an intermediate database, such as the file server 24, which in turn functions as the point of access for the PMA 12.

Detailed Description Text (17):
Referring now to the maintenance database 20, having available the most recent, as well as historical, maintenance data at the maintenance database for the weapon or aircraft being repaired is also extremely useful. Troublesome component malfunction signals can as a result be examined in far greater detail when the system generates a BIT flag, shown at 32 on the operator display 15, in response thereto. In general, this BIT flag may be any type of indicator that represents a problem identified by

system BIT logic. For example, if a component often exhibits erroneous fault symptoms when installed in a particular aircraft or weapon, such information is provided to the technician. The maintenance database is tied in to all levels of maintenance, and is populated in real-time by each repair activity as maintenance actions are initiated and completed. This feature allows real-time analysis of reliability and maintainability factors on a weapon by weapon or aircraft by aircraft basis. At higher levels of repair, the logged maintenance actions are already present upon arrival of a suspected faulty component. As soon as repairs to the unit are complete, this maintenance action is immediately available throughout the entire system.

Detailed Description Text (18):
The maintenance database 20 also logs and tracks all maintenance actions, thereby eliminating the need for paper forms to document maintenance actions. Work/repair orders are opened at the point of use, data is entered by the technician using the PMA. This information is available to all users instantaneously. The maintenance history of an aircraft or weapon is updated automatically. At higher levels of repair such as intermediate hub depots, the data is entered into the system via standard PC-based terminals. Real-time trend analysis is also performed by the system, as well as continuous tracking by serial number of every repairable component in the system. It is contemplated that custom sub-routines may also be implemented to extract visibility data for management and budgeting purposes.

Detailed Description Text (21):
The aircraft/weapon maintenance system 10 of the present invention also includes an optional feature BIT modeling logic, referred to as virtual testability, that is capable of substantially enhancing the diagnosis of failed weapon system components. For purposes of discussion, the virtual testability logic will be described as it is implemented in conjunction with an F-15 radar system. However, it is contemplated that this logic may be implemented in other environments in which the maintenance system of the present invention is implemented. The logic incorporates the logic of several different tests that, when implemented with the on-board diagnostics of the weapon or aircraft 14, provide a high degree of success in minimizing removal of still-operational system components. The virtual testability logic thoroughly analyzes existing data and may be implemented with little or no changes to existing aircraft system hardware. The virtual testability logic utilizes a nodal analysis to map, performance-related parameters, along with existing test access, to provide a more comprehensive assessment of performance than would normally be accomplished by the existing BIT logic alone.

Detailed Description Text (22):
Referring in particular to FIG. 2, test blocks representing several sequences of virtual testability logic implemented in conjunction with an F-15 radar system are shown generally at 40. A commercially available analytical program, known as Diagnostician and owned by Giordano Automation, Inc. of Sparta, N.J., is shown at block 42. The Diagnostician program utilizes a mapped diagnostic knowledge base and an artificial intelligence inference engine, mapped into aircraft tactical software, such as the operational flight program in the F-15. Other modeling techniques for BIT mapping are available and equally applicable.

Detailed Description Text (24):
Also, Diagnostician-generated test data can be input to its knowledge base. By applying this program to the maintenance system of the present invention, the knowledge base of the Diagnostician program is enriched at each inquiry through its access to the current worldwide histogram of similar fault frequencies across the entire fleet of operational aircraft.

Detailed Description Text (28):
Reference is now made to test block 48. In the current repair cycle, BIT and built in self tests (BIST) identify a failure and generate a BIT flag. Depending on the specific aircraft and sophistication of the application, some diagnostic action must take place before a repair is made. Generally, this diagnostic activity is performed using automated test equipment (ATE) at the aircraft itself, in an intermediate shop, or at the depot repair facility. At each level, the ATE is significantly different, having been built for field deployability or permanent residence in a depot. The tests applied are different as well. These different test routines yield inconsistent

results.

Detailed Description Text (30):
Reference is now made to test block 50. Current BIT/BIST and on-aircraft ATE does not use all information available to perform an accurate diagnosis. For example, radar systems have test ports that give access to bus 10 traffic and other information used in manufacturing check out and initial integration. On board maintenance recorders may be enhanced to record more or more pertinent inflight data. Radar sets constantly calibrate internally; this data often highlights component failure but is not currently used in diagnostic processes. Implementation of test block 50 to access the above data, coupled with advanced analytical programs, provides additional improvement of the maintenance system of the present invention.

Detailed Description Text (31):
When the above test sequences indicated in blocks 42-50 are integrated to form the virtual testability logic, the tests, in combination with the on-aircraft diagnostics tools represented in test block 52, substantially reduce the false removal rate of operational system components.

Detailed Description Text (34):
An alternate operating scenario also exists where a user may not desire to radiate or transmit during certain periods. In this circumstance, the block of technical manuals and/or maintenance data history for the aircraft or weapons to be maintained can be downloaded in bulk to the deployed file server, which can then be set up for autonomous operation in stand-alone mode with a plurality of PMAs. Once the blackout period has ended, maintenance information from opened work/repair orders is uploaded to the central database.

Detailed Description Text (35):
As is evident from the foregoing description, the weapon maintenance system of the present invention greatly simplifies the job of the technician. All pertinent test/trouble shooting/maintenance information is available immediately at the flight line, allowing all suspect faults and squawks to be accurately and efficiently resolved. Excess use of spare components due to false removals is nearly eliminated, maintenance times are significantly reduced, TO distribution/configuration control/update problems are eliminated, and maintenance data analysis is provided automatically, in real-time.

Detailed Description Text (37):
It is also contemplated that the system 10 according to the present invention may be utilized for information storage and retrieval in connection with other systems requiring remote access to any large amount of data in real-time. Such systems include large commercial enterprises, such as trucking companies, automotive repair activities, and retail establishments or any other technical endeavor requiring technician or engineering access to a large and constantly updated information database where there is extensive field maintenance required or where on-line expertise, a centralized data reference database for technical manuals or product or component configuration history is stored and in which satellite-based communications networks can be implemented to reduce overall system cost.

CLAIMS:

3. The system of claim 1, wherein said system provides equipment repair and maintenance information to said data transceiver in real-time.

17. An aircraft system, comprising:

an aircraft;

a central data warehouse located remotely from said aircraft including an electronic technical information database providing updated technical maintenance information on aircraft components, said central data warehouse further including a maintenance database for tracking historical maintenance data for said aircraft components, said central data warehouse further including technical support means for providing on-line technical assistance;

a remote wireless transceiver for transmitting data to and receiving data from said central data warehouse relating to maintenance of said aircraft;

test means for generating a BIT flag to identify failure of one or more of said aircraft components; and

diagnostics means initiated in response to said BIT flag generated by said test means for trouble shooting said aircraft components.

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L12: Entry 49 of 153 File: USPT

DOCUMENT-IDENTIFIER: US 6115656 A
TITLE: Fault recording and reporting method

Abstract Text (1):
A method for recording and reporting fault information pertaining to various components of an aircraft. The method involves recording a diverse plurality of information output from various line replaceable units (LRU's) and other components of the aircraft during takeoff, flight and landing through the use of a bulk storage device, such as an optical quick access recorder (OQAR), on an electronic medium. The electronic medium is then removed from the aircraft after landing and read by an appropriate apparatus. From this information a service technician is able to determine whether or not a fault indication recorded during flight is in fact a legitimate fault requiring the affected LRU to be removed from the aircraft for further diagnostic testing. The method significantly reduces the incidents of no-fault-found diagnostic test results and saves significant man hours which would otherwise be spent testing LRU's and other components which are in fact operating properly. Alternative embodiments of the method disclose making all information from the LRUs available and using multiple overlays to systematically reduce the data to

Abstract Text (2):
be recorded when the data proves to be too voluminous to record. The prioritizing of information is also disclosed so that LRU data of lesser importance is eliminated from consideration before more important information. The preferred methods minimize on aircraft data interpretation rendering unnecessary on-board maintenance processors and technicians for LRU troubleshooting.

Brief Summary Text (2):
This invention relates to systems and methods for monitoring and analyzing the performance of various components of an aircraft, and more particularly to a method of monitoring, recording, analyzing, condensing when necessary, and automatically reporting a large plurality of information from a plurality of components of an aircraft and making a determination as to whether any one or more of the components has provided a spurious fault indication signal.

Brief Summary Text (5):
Modern day aircraft, and particularly modern day military aircraft, typically make use of a large number of actuators, sensors, modules and other components. These components produce, or can be monitored to obtain, signals indicative of their performance during takeoff, landing and other aircraft flight phases. Often one or more aircraft components are monitored and/or controlled by a module called a "line-replaceable-unit" (LRU). An LRU is a highly complex module often incorporating several processors for controlling and/or monitoring one or more components or subassemblies of an aircraft. An LRU may be provided to monitor and/or control one or more external devices such as an actuator, valve, motor, etc., associated with a particular component or assembly of the aircraft. An LRU typically also generates output signals which can be monitored to determine if the LRU and/or the component with which it is associated is not operating properly. Examples of some of the LRUs associated with a C-17 aircraft are listed as follows to provide an appreciation as to the wide ranging and diverse functions of a typical military aircraft which the LRU's are responsible for controlling:

Brief Summary Text (6):

It will also be appreciated that aircraft such as the C-17 aircraft include a wide variety of actuators and sensors that provide output signals that can be monitored and recorded, but which do not have an LRU associated therewith. These components include, but are not limited to electrical and electromechanical actuators, valves, transducers, sensors, etc. Thus, it will be appreciated that most modern day aircraft, and especially modern-day military aircraft, have an extremely wide number of diverse components which are monitored to help insure proper operation.

Brief Summary Text (7):
With previously developed monitoring and testing systems, information from the LRU's and other components of an aircraft have been recorded on a quick access recorder (QAR). The quick access recorder records the information from the various LRU's and other components which are being monitored and stores the monitored information on a magnetic tape storage medium. Due to the inherent limitations of all magnetic storage media, some of the stored information may become corrupted. In some instances this might lead to inconclusive or erroneous fault indications should the magnetic storage medium indicate that, for example, a particular LRU has provided output signals indicating that a component associated therewith is malfunctioning when it is not.

Brief Summary Text (8):
Various systems for recording and/or analyzing operational parameters of various LRU's and other components of an aircraft are disclosed in the following U.S. patents, the disclosures of which are hereby incorporated by reference:

Brief Summary Text (9):
More recently, an optical quick access recorder (OQAR) has been used on board aircraft to record the information output by the LRU's and other components of the aircraft on an optical storage medium such as a high density optical storage disc. The optical storage disc tends to be far less susceptible to corruption than magnetic storage media and can hold a much greater amount of information than can be held by magnetic storage media. This has enabled even more information to be recorded (much of it in real time) pertaining to the various operational parameters of the aircraft and the performance of the wide ranging and numerous components, sensors and actuators of the aircraft than was possible with magnetic storage media.

Brief Summary Text (10):
Up until the present time, information recorded by the optical quick access recorder has only been used to generate information which indicates whether or not signals from the LRU's and other components of the aircraft are indicating fault conditions. Put differently, the information provided by the optical quick access recorder has not been used to determine if the fault indication is in fact a spurious fault indication. Up until the present time, information obtained from the optical quick access recorder generally has required highly trained service personnel to first interpret that a fault condition exists with a certain LRU or other component of the aircraft, and then either perform on-board testing that utilizes the aircraft as a test device or physically remove the effected component from the aircraft for diagnostic testing. Sometimes, diagnostic testing may not identify a problem with the LRU or other component. Often, the diagnostic testing of a removed LRU can consume several hours by a highly trained service person in an effort to determine the cause of the fault indication. In some instances, the effected LRU or component is eventually reinstalled in the aircraft without ever being able to determine what caused the initial fault indication. This has led to high "cannot duplicate" ("CND") and/or "no-fault-found" ("NFF") rates for various LRU's and other components.

Brief Summary Text (11):
Two challenges have underscored the high NFF rate: 1) the same LRU often makes repeated back-shop visits and can lead to "intermittent failure" troubleshooting (Intermittent testing often results in days of troubleshooting since a several hour fault detection test is repeated several times); or 2) Service personnel may become sensitized to repeated NFF test results. Since testing of an LRU or other component may take considerable effort using specialized equipment and skills, it will be appreciated that significantly reducing the incidence of no-fault-found results of diagnostic tests can represent a very significant cost savings. The following table illustrates test times required for determining if a fault condition exists for 38 LRU's of the C-17 aircraft by McDonnell Douglas using automatic test equipment.

Brief Summary Text (12):
It would therefore be highly desirable to provide some method of analyzing and automatically reporting information for making a preliminary determination as to whether a fault indication provided by an LRU or other component of an aircraft is in fact a legitimate fault indication which will require further diagnostic testing of the LRU or affected component, or which is a spurious fault indication. In the case of a spurious fault indication, the LRU or component under investigation would not have to be either tested on-board the aircraft utilizing the aircraft as a test device or removed from the aircraft and subjected to several hours of testing in an effort to duplicate the fault condition or to find a malfunctioning subcomponent or subassembly of the LRU or other component. Accordingly, such a method could significantly reduce the instance of wasted man hours attributed to both on and off-aircraft testing of LRU's and other components of an aircraft which are, in fact, in perfect working order, but which have provided output signals which may indicate that same are not operating properly.

Brief Summary Text (13):
It would also be highly desirable to provide a method for recording and analyzing information from a bulk storage device, which provides user readable information enabling service personnel to quickly determine whether various LRU's and other components of an aircraft are operating within acceptable operating parameters without the need for using a variety of different computers and equipment, and without the need for requiring computers to be taken on board the aircraft to download information from various on-board computers of the aircraft.

Brief Summary Text (14):
It would also be desirable to provide a method for recording and analyzing information from an aircraft which can quickly enable service personnel to determine if one or more LRU's of the aircraft or other components need to be removed for further diagnostic testing, and which also enable qualified service personnel to quickly determine if information from an LRU or other component which appears to suggest a fault condition is in fact explained by the presence of other signals which verify to the service person that no fault condition exists with the particular LRU or component under investigation. Most preferably, this failure filtering technique would be automatically reported to service personnel.

Brief Summary Text (15):
It would also be highly desirable to provide a method for automatically condensing what is recorded, as necessary. Current maintenance recorder maps have finite memory capacities and preclude the (real-time) capture and recording of all available fault data. This has often prevented a significant portion of LRU fault data from being recorded since a minority amount of LRU data can fill the entire maintenance recorder map space. Therefore, a method that automatically condenses what is recorded and automatically updates any condensing as needed, can support the above desirable method reporting while finite recorder map limitations exist.

Brief Summary Text (17):
The above and other objects are provided by a preferred fault recording and reporting method in accordance with the present invention. The method involves using a mass storage device such as an optical quick access recorder (OQAR), wherein the electronic medium is easily removed from the aircraft without requiring aircraft power or specialized equipment or skills. The electronic medium monitors and records a large and diverse plurality of output signals from line replaceable-units (LRU's), actuators, valves, sensors and other various components of an aircraft (in real time). Information is recorded on an optical storage disc which is read by an appropriate optical disc reader associated with a personal computer after a mission flight is accomplished. The information is manipulated by software in the personal computer and presented to the user in a user-friendly format allowing the user to quickly verify whether or not a recorded fault indication is in fact a legitimate fault. By making an automated determination immediately after the flight or mission is accomplished, significant time can be saved by avoiding on-board testing or manually removing one or more LRU's or other components from the aircraft and performing extensive testing merely because a component has provided a signal during flight which is indicative of a fault condition, but which component is, in fact, operating correctly.

Brief Summary Text (18):
The method of the present invention permits a user to view a report from recorded mass storage device data made during a flight which would indicate that a fault condition exists, but which because of other recorded information presented to the user, would indicate to the user that in fact no fault condition occurred. Thus, it can be determined, before any service operations are performed on the aircraft, which components in fact do need to be removed for further testing and/or service and which components may be operating satisfactorily regardless of fault indication signals that they may have provided during a flight. The method of the present invention can therefore serve to drastically reduce the no-fault-found occurrences typically experienced with present day diagnostic and servicing procedures.

Brief Summary Paragraph Table (1):
System/Component (AF nomenclature) Acronym Emergency Egress Sequencer ES Aerial Delivery Locks Control Panel ADLCP Cargo Delivery System Control-Status CDSCSP Panel Aerial Delivery System Controller ADSC Aircraft Fault-Function Indicator Panel AFFIP Sensor Signal Interface SSI Antiskid-Brake Temperature Monitor ABTMCU Control Unit Electronic Engine Control EEC Electronic Engine Control (for Auxiliary EEC Power) Auxiliary Power Unit Control Panel APUCP Environmental System-Fire Detection ESFDCP Control Panel Temperature Control Panel TCP Environmental Control System ECSC Controller Manifold Failure Detection Controller MFDC Cabin Pressure Controller CPC Cabin Air Pressure Selector Panel CAPSP Windshield Anticing Control Box WAICB Window Defogging Control Box WDCB Battery Charger no acronym Generator Control GC Electrical System Control Panel ECP (Electrical Control Panel) Static Frequency Converter no acronym (60 Hertz Converter) Static Power Inverter no acronym Bus Power Control Unit BPCU Hi-Intensity Wingtip Lights Power no acronym Supply (no AF nomenclature) Upper & Lower Beacon Light Power no acronym Supply (no AF nomenclature) Power Supply-Dimming Unit no acronym Battery Charger Set no acronym (Emergency Lighting Battery/Charger) Hydraulic System Controller HSC Hydraulic System Control Panel HSCP Fuel System-Engine Start Control FSESCP Panel Liquid Quantity Indicator LQI Ground Refueling Control Panel GRCP Fuel Quantity Computer FQC Fluid Purity Controller FPC Bearing-Distance-Heading Indicator no acronym Engine-Thrust Rating Panel Display ETRPD Signal Data Recorder no acronym (Quick Access Recorder) (QAR) Standard Flight Data Recorder SFDR Propulsion Data Management PDMC Computer (Aircraft Propulsion Data Management (APDMC) Computer) Flight Control Computer FCC Actuator Flight Control Panel AFCP Automatic Pilot Control-Indicator APCI Ground Proximity Warning Control GPWCP Panel Spoiler Control-Electronic Flap SCEFC Computer Display Unit DU (Multi Function Display) (MFD) Multifunction Control Panel MCP Air Data Computer ADC Inertial Reference Unit IRU Head-Up Display Unit ("Glass-cockpit" HUDU Display) Digital Computer DC (Mission Computer) (MC) Display Unit (DU) (Mission Computer Display) (MCD) Data Entry Keyboard DEK (Mission Computer Keyboard) (MCK) Intercommunications Set Control ICSC Intercommunications station no acronym Audio Frequency Amplifier no acronym Public Address Set Control no acronym Cordless Headset no acronym Radio Receiver-Transmitter no acronym CargoWinch Remote Control no acronym Battery Charger no acronym Communication-Navigation Equipment CNEC Control Communications Equipment Control CEC Central Aural Warning Computer CAWC Warning And Caution Computer WACC Warning and Caution Annunciator WACAP Panel Signal Data Converter SDC Coder Decoder Keying Device CDKD Transponder Set Test Set no acronym (I-Band Transponder Test Set) (TTU)

Drawing Description Text (9):
FIG. 7 is a flowchart illustrating an algorithm for monitoring and recording multiple impact data from a sensor on-board the aircraft; and

Drawing Description Text (10):
FIG. 8 is a flowchart illustrating the overall implementation of the alternative preferred method of the present invention to create a closed loop monitoring system by which recorded fault data is used to optimize subsequent flight operations of an aircraft.

Detailed Description Text (2):
Referring to FIG. 1, the various components typically used with the method of the present invention are illustrated. The aircraft is denoted as a C-17 military aircraft

10, although it will be appreciated immediately that the preferred method of the present invention is applicable to virtually any commercial or military aircraft, as well as other non-fixed wing aircraft. The method of the present invention could also easily be used with little or no modification to evaluate fault indications provided by various components or computers of other military vehicles including, but not limited to, tanks.

Detailed Description Text (3):
The aircraft 10 includes a "Warning And Caution Computer" (WACC) 12 which supplies Warning and Caution System (WACS) bus signals to an "Aircraft Propulsion And Data Management Computer" (APDMC) 14. The WACS bus contains signals from many LRU's, such as an Antiskid-Brake Temperature Monitor Control Unit (ABTMC) and Fuel Quantity Computer (FQC). The APDMC 14 is commercially available such as from Teledyne Controls Corporation, Los Angeles, Calif. and is more commonly called a data memory unit (DMU) in industry commercial applications. The APDMC 14 also monitors mission bus signals from the mission computer, and the mission bus contains signals from many aircraft LRU's. Note that a DMU is used for monitoring many busses, as well as analog and discrete sensor signals which do not have an LRU or communication bus associated therewith. The APDMC 14 monitors a very large and diverse plurality of operating parameters of the aircraft and generates a plurality of output signals indicative of the operation of the various line-replaceable-units (LRU's) and other diverse components of the aircraft. Examples of other components which the APDMC 14 can monitor are listed in the "Background" portion of this document.

Detailed Description Text (4):
The APDMC 14 generates a large plurality of output signals which can be representative of dynamic aircraft data, propulsion data and real-time fault data. The dynamic aircraft data is recorded in a standard flight data recorder (SFDR) 16, as is well known in the aircraft industry. The APDMC 14 transmits output data that ARINC 573 bus 15 can be recorded on an optical quick access recorder (OQAR) 18 on an optical storage medium 20. The OQAR 18 is also a commercially available item available such as from Teledyne Controls Corporation. The use of an optical disc for storage greatly increases the data storage capacity while significantly reducing the amount of lost data which could otherwise be experienced with a magnetic storage medium which is susceptible to drop outs and other well known limitations. The optical storage disc 20 has a storage capacity of at least about 120 mb, and preferably about 230 mb or higher.

Detailed Description Text (5):
The APDMC or DMU can be used to monitor any aircraft parameter for optical disk recording, and the present invention exploits two data recording capabilities for NFF minimization: (1) multiple maps or overlays support the recording of subassembly or detail failure data, and (2) recent DMU developments support maintenance updates of which parameters are optically recorded using an Application Generation Station (AGS). The AGS is also a commercially available item available such as from Teledyne Controls Corp. These two capabilities support the routing of increased LRU failure data and other aircraft parameters by maintenance personnel for enhancing the utility of the present invention. This enhancement forms the basis for the alternative preferred method described in detail for FIGS. 3-8.

Detailed Description Text (6):
After the flight of the aircraft 10 has concluded, the optical disc 20 is removed from the OQAR 18 and read by an optical disc reader 22 associated with a personal computer 24. The personal computer 24 is used with conventional data base software such as "FoxPro.RTM." available from Microsoft Corporation. The software is used to generate a database of information from which reports are generated relating to propulsion data recorded during flight, avionics flight instrument and navigation (AFIN) reports indicating faults with various LRU's and other components of the aircraft 10, and other information relating to the particular flight such as altitude, aircraft speed, etc. over the course of the flight. It is a principal advantage of the method of the present invention that a high performance personal computer 24 is used to generate a large database of user readable information from which reports can be compiled which can be quickly read and interpreted by qualified service personnel or technicians familiar with the various operating components of the aircraft 10. The automated reports 26-30 generated by the personal computer 24, being in user readable form,

allow various individuals responsible for maintaining proper operation of the various LRU's and components of the aircraft 10 to determine quickly and easily, after a mission flight is concluded, the pertinence of the information collected during the flight, and whether any LRU or other component has provided output signals indicating that same is not functioning properly.

Detailed Description Text (7):
With previously developed systems, several independent computers and several independent software programs were typically used to compile the information, in user readable form, necessary to make a determination as to whether or not one or more LRU's or other components had generated a fault signal. Typically, a "ground read-out equipment" (GRE) portable computer is required to download data from the SFDR. A dedicated lap top computer was also required for downloading information recorded in a mission computer (MC) of the aircraft. This required a highly-skilled technician to board the aircraft after the flight and manually couple a computer to either the mission computer or SFDR to obtain recorded LRU fault information or aircraft dynamic data, respectively. LRU subassembly failure data can also be downloaded from the LRU's by the use of numerous different interconnecting devices, such as power supplies, air-cooling and loads, and computers. Propulsion data was also generated independently through separate software. Thus, it will be appreciated that a significant degree of time was required by highly-skilled service persons, as well as numerous independent computer components, before the necessary information could be obtained for determining whether or not one or more LRU's or

Detailed Description Text (8):
other components have provided spurious fault indications during a just-completed flight. The step of using the personal computer 24 has virtually eliminated the necessity of having several service technicians board the aircraft 10 after a flight with various types of equipment to obtain the information needed to make determinations as to how the various components of the aircraft 10 performed during the flight.

Detailed Description Text (9):
Referring now to FIG. 2, a flow chart 32 is shown which illustrates the steps of the preferred method of the present invention. Following a flight, the relevant information relating to reported LRU and other component faults is obtained, as indicated at step 34 and results in generating the automated reports 28 via personal computer 22 in FIG. 1. This step involves making a determination if sufficient LRU fault data and other parameters have been recorded for NFF minimization. If not, maintenance personnel can attempt to supplement the recorded data with other information related to a particular aircraft in an effort to generate sufficient data to make a determination regarding the operation of various components being evaluated. This supplementing of information is an important feature of the closed loop monitoring described in detail for FIG. 8, in connection with the alternative preferred method of the present invention.

Detailed Description Text (10):
The obtained LRU fault information is then compared with other relevant recorded flight information by the service technician or automatically by software, such as FoxPro.RTM., as indicated at step 36, whenever appropriate, in an effort to determine why the fault indication may have occurred. For example, a fault indication may have been provided at a certain time during the flight which indicates that the aircraft's altimeter malfunctioned temporarily or intermittently. However, a qualified aircraft service technician would also understand that the altimeter would not function properly if the aircraft was subjected to a roll of, for example, more than 30.degree. during flight. In this example, the flight service technician could review other information provided in report form, such as by report 30 in FIG. 1, to determine that at a certain time during flight the aircraft 10 experienced a roll of more than 30.degree. for a limited time or at several times during flight. From this information, the service technician could readily determine that the fault indications provided relating to the altimeter are in fact spurious fault indications and that the altimeter, in fact, operated properly during the entire flight of the aircraft 10. The preferred embodiment of the said invention could alternatively automatically report this to the service person.

Detailed Description Text (11):
Referring further to FIG. 2, the service technician makes a determination from the comparison carried out at step 36 as to whether or not any LRU or other component needs to be physically removed from the aircraft for further diagnostic testing and/or repair, as indicated at step 38. If this determination produces a "no" answer, then no further action is needed by the service technician. If the answer is "yes" to the test at step 38, the service technician knows that the fault indication is a legitimate fault indication, and the affected LRU or component is removed for diagnostic testing, as indicated at step 40. Note that following LRU or component removal, the fault data can be used to aid in off-aircraft troubleshooting.

Detailed Description Text (12):
By the method of the present invention, the incidents of no-fault-found diagnostic results can be significantly reduced. The method of the present invention provides service personnel with the information needed to quickly determine whether recorded fault indications during the flight of an aircraft are in fact legitimate fault indications or whether they occurred due to other in-flight circumstances which would have understandably affected the LRU or component which generated the fault indication. The method of the present invention thus can save significant man hours which would otherwise be expended by testing components or LRU's which have generated fault indications, which are ultimately determined to be operating satisfactorily. Most important, the preferred embodiment of the present invention supports automatic NFF filtering reporting.

Detailed Description Text (15):
Steps 134, 136, 138 and 140 correspond directly to steps 34-40, respectively, of FIG. 2. Step 141 involves making an automated engineering report in the event the LRU is found to have no fault to therefore support aircraft operation improvement. Step 139 entails automatically reporting if LRU fault isolation can be improved by further optimizing the fault data (prior to the next flight). Usage of step 139 is outlined in greater detail in connection with the FIG. 6 flowchart.

Detailed Description Text (16):
Step 142 involves automatically reporting if the performance (and diagnostic) test(s) of the LRU which has generated a fault verifies the original aircraft fault, and therefore if the original reported fault indicates a legitimate hardware problem with the LRU. If a "no" answer results at this step, then it is determined that an LRU was incorrectly removed. This can occur for two reasons: 1) an incorrect preliminary assessment was made (i.e., the recorded data was reported erroneously and indicated a fault when none existed) or 2) the LRU did not have all its associated fault data recorded due to recording constraints, such as maintenance recorder memory map or bus throughput limitations. For the incorrect preliminary assessment, step 144 leads to an update of the step 138 reporting, or, more likely, the LRU will not have all associated fault data recorded and step 104 data recording optimization will be needed in connection with updated assessment reporting (138). This step 144 usage is outlined in greater detail in connection with the FIG. 5 flow chart.

Detailed Description Text (19):
Before addressing the flowcharts of FIGS. 4 and 5, it should be appreciated that the number of data words generated from diagnostic data of even a minority of the LRUs on board on an aircraft can result in a minority of the LRUs filling the entire memory map of a maintenance recorder. For instance, the example LRU has 100 and 200 data words per second available for FIGS. 4 and 5 recording, respectively, therefore the 300 words for this LRU can occupy the majority for a 512 word map. It will also be appreciated that a 12 bit QAR word can record a parameter range from 0 to 4095 with a LSB weight of 1. If the 12 bit LSB weight is a value of 10 or 0.1, the maximum value becomes 40,950 or 409.5, respectively. A 12 bit word can use a sign bit, and with an LSB weight of "1" its recording range is +/-2,047. The sign bit is used to make the remaining 11 bits negative or not. A parameter can also be recorded at various rates if desired. Faster rates require increased map space (i.e., more memory). For example, a 12 bit parameter recorded 16 times per second requires 16 map words. Lastly, a 12 bit QAR word is often utilized for 12 LRU test results, indicating a pass or fail result by either setting a bit or not.

Detailed Description Text (22):

If the inquiry at step 152 produces a "no" answer, as will occur for many LRU's since even a minority of information from an LRU can fill the entire maintenance recorder map, then overlays are created for the parametric self-test data generated by the example LRU, as indicated at step 158. This involves utilizing LSB weights and recording rates for space sharing optimization, as described above, to reduce the example 100 words of LRU data to 26 words. The example LRU can have internal clock speed and other parametric data from each of four different circuit boards. It would be desirable to record the clock and other circuit board parameters continuously, but this can be difficult or impossible in view of the large amount of data that can be generated. Step 158 takes into account LRU factors such as redundancy and complimentary operation that contribute to only one of the four circuit boards actually generating output signals controlling aircraft performance at any given time. This can be the case for two pairs of redundant circuit boards, where only one board within a redundant pair generates aircraft operational output signals at any given time and the pairs are complimentary. As an example, one pair may be used during aircraft climb and the other during descent. Thus, a coded overlay word consisting of three bits dictates which circuit board parametric data (of the four) is being recorded at any given time. The net effect is that 26 words are now required for recording, or roughly one-fourth the total available parametric data plus the overlay word at step 158. It will be noted that other factors can result in either half of the available parametric words being used initially, or an overlay from two of the example LRU circuit boards being recorded, or no overlay attempts made at all.

Detailed Description Text (24):
If the answer at step 160 is "no", then this LRU parametric data is overlayed with data of another LRU, as indicated at step 162. This degree of overlaying involves further selectively reducing the self test data generated by the initial LRU of this example and the new LRU by sharing the new LRU's recorded data with the initial LRU. The new LRU can have an overlay similar to that just attempted at step 158 for the initial LRU, but it generates aircraft operational output signals only during ground operations. Thus, the new LRU overlay can be further shared with the initial LRU (climb/descent) overlay at step 162.

Detailed Description Text (25):
At step 164, another determination is made if the new overlays created at step 162 will fit within the memory map of the maintenance recorder. If they will, then the information is recorded and another LRU is analyzed, as indicated at step 156. If not, then a pre-designated, least most important LRU parameter is removed, as indicated at step 166, and further overlays are again created and another attempt is made at recording the remaining LRU parametric data, as indicated at steps 158-164. Step 166 causes information relating to one parameter at a time to be removed, in an effort to enable overlays to be created which have a sufficiently limited number of data words such that same can be recorded in the memory map space available on the OQAR. In this regard it will be appreciated that each parameter of operation of an LRU for which parametric data is generated can be assigned a "priority". This enables that information which is predetermined to be least important or critical to the operation of the aircraft to be eliminated in accordance with the pre-established priority designations.

Detailed Description Text (31):
The FIG. 5 LRU example, especially with only one self-test discrete recorded, can easily lead to either a "no" at step 142 or a "yes" at step 146, and execution of the alternate preferred methods data optimization feature. For example, the example LRU can have a component self-test function (incorrectly) set per high aircraft vibration levels. This may result in a "no" at step 142 since LRU testing performed off aircraft is normally done without vibration applied. Additionally, actual hardware failures to other component self-test functions can further mask vibration induced failures. Thus, step 142 occurrences will increase the cost (i.e., life cycle cost) of the LRU, and steps 144, 104 and the steps of FIG. 5 are then performed again (to reduce this increased cost). Finally, the recording of the example LRU, 2,400 self-test discretes would support rapid identification of the LRU component self-test function susceptible to vibration.

Detailed Description Text (32):
The example LRU could instead be failing intermittently, and while true hardware

degradation is causing this, the recording of only one summary discrete results in off-aircraft end-to-end performance tests to be done repetitively in an attempt to locate the fault. A "yes" at step 146 will often occur for intermittent testing, since each instance can require many hours, or even days of test time. This test time contributes to an increase in LRU (life cycle) cost, leading to step 144, 104 and FIG. 5 performance again. The recording of the 2,400 self-test discretes support dramatically reduced test times since an intermittent LRU failure will now result in the given component functional test to be repeated, and not all of the other LRU end-to-end tests.

Detailed Description Text (36):
Referring now to FIG. 7, yet another modification of the method shown in FIG. 4 can be employed to compile and record information from one or more sensors, which information might in some instances be too voluminous to record without employing one or more overlays. An example of such an application is the use of a transducer adapted to monitor an aircraft structure for impact assessment. In this instance up to 6000 sensor testing words can be required for representing a 0.5 second structural impact, where the 6000 words of data is achieved through a very high rate of sampling the output of a particular sensor.

Detailed Description Text (39):
Furthermore, the alternative preferred method supports automatic execution, or continual improvement, of the methods of FIGS. 3-7 using a commercially available PC. This method for improvement is shown in FIG. 8. Similar to that discussed in FIG. 1, aircraft maintenance media 200 can be an optical disc removed from the OQAR 202 following the flight. The disk is then inserted into a PC 204 for automated reporting 206. A Digital Flight Data Management Unit (DFDMU) 208 can be used in the aircraft for alternate preferred method implementation, and either a PCMCIA card or an optical disk can comprise the maintenance media 200. The maintenance media 200 can be removed following the flight of an aircraft and then inserted into the PC 204 for automated reporting. The automated alternate preferred method assessment reporting 206 is shown as step 138 in FIG. 3. If either step 139, 142 or 146 of FIG. 3 result in a "yes", "no" or "yes", respectively, the report recipient 210 can then be informed that the PC 204 is automatically updating the maintenance map.

Detailed Description Text (40):
This maintenance map optimization of FIGS. 4-7 is performed by the PC 204 using the floppy disk application generation system (AGS) file or optical disk configuration file for the DFDMU 208 or OQAR 202, respectively. After the floppy or optical disk 200 is inserted into the DFDMU 208 or OQAR 202, the recorder map is then updated. A result of FIG. 8 performance is the novel use of unique maintenance recorder maps for aircraft within a fleet of the same aircraft type.

CLAIMS:

1. A method for analyzing and recording information relating to the operation of a plurality of line replaceable units (LRUs) of an aircraft for subsequent fault analysis, said method comprising the steps of:

a) monitoring and storing all available information generated by a plurality of LRUs relating to a plurality of operational parameters of said aircraft;

3. The method of claim 1, further comprising the step of assigning each one of a subplurality of said information relating to a specific parameter of operation a priority in accordance with its importance to aircraft operation.

4. The method of claim 3, further comprising the step of eliminating one or more of said parameters of operation in accordance with said priority such that least ones of said parameters which are of lesser importance to aircraft operation are eliminated prior to ones of said parameters that are of greater importance.

following the reporting of said stored OQAR information, again performing steps a) through e) in support of continual improvement in reducing no-fault-found incidences with said LRUs of said aircraft.

6. A method for analyzing and recording information relating to the operation of a line replaceable unit (LRU) of an aircraft onto a recording medium for subsequent analysis, wherein the LRU includes a plurality of circuit assemblies, said method comprising the steps of:

a) monitoring and storing all available information generated by an LRU during operation of an aircraft associated with said LRU;

11. A method for analyzing and recording information generated by a line replaceable unit (LRU) of an aircraft onto a recording medium for subsequent analysis, wherein said information comprises information relating to a plurality of distinct operational parameters of said aircraft, said method comprising the steps of:

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L12: Entry 17 of 153 File: USPT

DOCUMENT-IDENTIFIER: US 6314350 B1
TITLE: Methods and apparatus for generating maintenance messages

Brief Summary Text (5):
The sensor selection logic also generates a selection status (SST) number which indicates a type of fault accommodation that has been taken. The SST number is then used by maintenance logic to generate maintenance messages. Specifically, if a fault condition SST number is set for a specific period of time, generally referred to as a persistence time, then a maintenance message is transmitted to an aircraft central maintenance system. Post-flight maintenance actions typically are based on these messages.

Brief Summary Text (7):
By not having the ability to generate maintenance messages for these fault conditions, i.e., faults due to intermittent conditions and "in-range" faults, the ability to trend a fault condition and predict when a hard fault will occur is not available. This prediction capability is particularly useful for maintenance planning since many engine fault conditions are capable of causing aircraft delays and cancellations.

Brief Summary Text (10):
The maintenance logic utilizes outputs from the monitoring logic to generate maintenance messages. More specifically, the maintenance logic utilizes the SST number transition counter output to generate a real-time maintenance message if the transition counter number exceeds a threshold limit. The SST number time duration table also is used by the maintenance logic to detect a pattern from the table information so a type of fault can be automatically detected and to generate an appropriate post-flight maintenance message.

Drawing Description Text (3):
FIG. 2 is a block diagram of an aircraft data acquisition system;

Drawing Description Text (5):
FIG. 4 is a block diagram of an aircraft central maintenance system;

Detailed Description Text (5):
Monitoring logic 12 monitors the SST number for each input sensor and records, in a transition counter, the number of times the SST value changes from its previous value during a flight. Monitoring logic 12 also monitors the SST number for each input sensor and generates a time duration table that indicates the total time that a SST value is recorded at each of its possible states during the flight. Maintenance logic 14 generates a real-time maintenance message when the transition counter value exceeds a specific threshold limit.

Detailed Description Text (6):
FIG. 2 is a block diagram of an aircraft data acquisition system 20. Rather than being stored in ECU 10 (FIG. 1), monitoring logic 12 and maintenance logic 14 may be stored in system 20. As in ECU 10, logic 12 and 14 are stored in a non-volatile memory of system 20.

Detailed Description Text (8):
FIG. 4 is a block diagram of an aircraft central maintenance system 40. Post-flight pattern detection algorithm 32 may be stored in aircraft central maintenance system 40

rather than in ground based system 30 (shown in FIG. 3) and, as described below in more detail, generates maintenance messages. Post-flight pattern detection algorithm 32 is stored in a non-volatile memory of aircraft central maintenance system 40. Post-flight pattern detection algorithm 32 generates a post-flight maintenance message when a fault condition pattern is recognized in the time duration table data.

Detailed Description Text (14):
Maintenance logic 14 compares the transition counter values to a threshold limit 58, during the flight. If a counter value exceeds the limit 58, then a real-time maintenance message is generated 60 immediately. For example, for a flight that has an intermittent N2 sensor fault condition as represented in Table II, no maintenance message would be generated if the threshold limit is 6 or more. However, for that same flight, a maintenance message would be generated if the threshold limit is 5 or less.

Detailed Description Text (15):
With threshold limit 58 and maintenance logic 14 installed in ECU 10 (FIG. 1), the output of ECU 10 is a discrete signal indicating a specific fault condition. This information is transmitted from ECU (10) on a data bus. Aircraft data acquisition system 20 and aircraft central maintenance system 40 receive the information via the bus, and both systems 20 and 40 generate a maintenance message based on the specific fault condition. If threshold limit 58 and maintenance logic 14 are installed in aircraft data acquisition system 20, then the message would only be generated by system 20.

CLAIMS:

1. A method for monitoring a status of a sensor in an aircraft, said method comprising the steps of:

7. Apparatus for monitoring a status of a sensor in an aircraft, said apparatus comprising a processor programmed to:

13. Apparatus in accordance with claim 7 wherein said processor is located in at least one of an electronic control unit, an aircraft data acquisition system, a ground-based system, and an aircraft central maintenance system.

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L12: Entry 9 of 153 File: USPT

DOCUMENT-IDENTIFIER: US 6356437 B1
TITLE: System, apparatus and method for providing a portable customizable maintenance support instruction system

Brief Summary Text (2):
The present invention relates in general to the field of real-time instruction and maintenance support, and more particularly, to the use of a portable system, apparatus and method for the remote repair or maintenance of complex mechanical systems that is hands-free and which is customizable on-site for a particular piece of equipment, process, operation or system.

Brief Summary Text (5):
In order to remain competitive, many industries, such as the aircraft industry, have increasingly automated their assembly processes through the use of computer-controlled equipment. The increase in complexity of the mechanical and computer systems in the airline, automobile, and other industries that rely heavily on automation, have led to the need for an increasingly sophisticated labor force. Unfortunately, the labor markets are failing to meet the demand for highly competent repair and maintenance employees at reduced costs. As equipment becomes more complex, the diagnosis of faults and maintenance of the equipment have, likewise, become more complex.

Brief Summary Text (12):
The present invention provides a light, portable hands-off or hands-free maintenance and repair system, using a task-specific hypertexted, animated, voice-synthesized, and/or voice-activated communications and search engine that is able to access a task-specific database. The instructional program or engine is made task-specific by accessing a database of machine, process or operational specific data, which may be computer data, audio and even video clips that provide the user with real-time instructional information about the task or tasks that the user is to perform at a remote location.

Detailed Description Text (3):
The present invention is directed to a system, apparatus and method of providing real-time, on-line help to users that may need assistance in operating, repairing or maintaining a complex system. The present invention is not only a complete, interactive, learning repair and maintenance system, it is customizable for the individual machine that is in need of operator intervention.

Detailed Description Text (25):
FIG. 2 shows a chart with the operational access that SIMON provides to the user of the SIMON portable computer and system. The SIMON engine, designated as 200 provides the user 202 access to a variety of functionalities. The SIMON engine 220 is able to access one or more modules, in real-time, to provide the user 202 with information as to the status of the main application 204 and, e.g., a help menu 208 for running the main program or any of the one or more modules that serve the user 202. For example, the user performing a specific task at a remote location may access the maintenance procedures module 206 to obtain step by step instruction and maintenance procedures for repairing a particular piece of equipment or for the use of certain tools. The SIMON engine 200 also allows a user that is in the maintenance procedures module 206 to access either the parts search module 210 or the parts locator module 212, which permit the user to find out parts numbers and availability in the parts inventory, locally or globally.

Detailed Description Text (26):
The SIMON engine 200 is also able to interface with a reports module 214 that is capable of taking the maintenance procedure information derived from the maintenance procedure module 206 and submit a report, in real-time, on-line or in a subsequent data dump. The report may be used not only to report that the repair has been completed, but may also be capable of providing full parts listings for any new parts used or needed. By tying the reports module 214 into a LAN or WAN, the report may be used to standardize reporting and maintenance procedures without the vagaries and informality often found with hand-written maintenance records. The reports module 212 itself, or a compatible application, may also provide a docket of maintenance to be conducted or that has been missed to update maintenance records.

Detailed Description Text (169):
SIMON is particularly useful when a user at a remote location is presented with a task when dealing with wires or equipment that is color coded. The use of a color video camera with sufficient resolution and transmission rate will be required to provide the CSC with valuable, and perhaps critical information. The use of a color camera will be particularly important to reduce the risk of injury to maintenance and repair personnel that may not be aware of the operational dangers of a particular piece of equipment or process when communicating with a CSC in real time.

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L12: Entry 1 of 153 File: USPT

DOCUMENT-IDENTIFIER: US 6418361 B2
TITLE: Aircraft maintenance tracking system

Abstract Text (1):
An aircraft maintenance tracking system for tracking aircraft maintenance required on an aircraft includes means for tracking accumulated usage data of the aircraft, means for receiving a list of routine tasks required to be performed on the aircraft, means for tracking task accomplishment data for each routine task, means for determining a maintenance due point for each routine task, means for identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated usage data of the aircraft is less than a user-defined critical value, and means for reporting maintenance due tasks.

Parent Case Text (2):
This application claims priority from Provisional Application No. 60/168,400, filed Dec. 1, 1999 for "Computerized Aircraft Maintenance Tracking Programming System" by Barry Sinex. Reference is hereby made to the following copending applications, which were filed on even date with the present application: "Dynamic Aircraft Maintenance Management System", by Barry Sinex, application Ser. No. 09/728,773, filed Dec. 1, 2000; "Aircraft Maintenance Program Manager", by Barry Sinex, application Ser. No. 09/728,579, filed Dec. 1, 2000; "Dynamic Aircraft Maintenance Production System", by Barry Sinex, application Ser. No. 09/734,319, filed Dec. 1, 2000; "Dynamic Assignment of Maintenance Tasks to Aircraft Maintenance Personnel", application Ser. No. 09/727,671, filed Dec. 1, 2000 by Barry Sinex; and "Dynamic Management of Aircraft Part Reliability Data", by Barry Sinex, application Ser. No. 09/728,565, filed Dec. 1, 2000.

Brief Summary Text (2):
The present invention relates to the field of aircraft maintenance. More specifically, the present invention relates to a system and method for tracking aircraft maintenance required on an aircraft.

Brief Summary Text (3):
Aircraft maintenance occupies a key position in airline operation because such maintenance is essential to the safety of passengers and the reliability of airline schedules. Each aircraft has its own maintenance requirements which are designed to keep the aircraft in an airworthy condition. These aircraft maintenance requirements typically originate from the aircraft's manufacturer, and can be revised throughout the life of the aircraft by the aircraft manufactures, the Federal Aviation Administration (FAA) and/or the Maintenance Review Board (MRB).

Brief Summary Text (4):
These aircraft maintenance requirements are documented in aircraft-specific MRB documents. An MRB document details each task that must be accomplished on a particular aircraft, the requirements of that task, and the frequency with which the task must be performed. The MRB document includes tasks that need to be accomplished anywhere from once a day to once every 20 years, as well as tasks that need to be accomplished after the aircraft has achieved a specific number of flight hours, flight cycles or other triggering indicia. For most major aircraft types, the MRB document lists somewhere between 800 to 2,000 different tasks.

Brief Summary Text (6):

Because an aircraft produces revenue only when it is flying, it is essential for airline management to keep maintenance time at a minimum. Thus, airlines commonly group tasks together (into letter-checks) rather than perform the tasks one at a time as they come due. Letter checks commonly include "A checks", "B checks", "C checks" and "D checks", with A checks occurring most frequently and having the fewest number of tasks. A and B checks typically can be performed overnight in a "line maintenance" environment, in which, assuming no complications arise, the aircraft typically loses little or no flight time. In this environment, the aircraft remains airworthy because it can be reassembled quickly.

Brief Summary Text (7):
Conversely, C and D checks comprise a greater number of tasks, many of which require a substantial amount of time to complete. Thus C and D checks are typically performed in a heavy maintenance environment in which the aircraft is taken out of service. In this environment, an aircraft is taken into a hanger, where it is taken apart, inspected, fixed and reassembled during the course of one week to over a month. During this heavy maintenance period, non-routine tasks (those not detailed in the MRB document) are identified (often as a result of an inspection mandated by the MRB document), and parts that have reached their hard limits specified by the MRB document are replaced. Upwards of 300 persons (including cleaners, mechanics, lead mechanics, inspectors and lead inspectors) may work on the maintenance of the aircraft. In addition, a management team including managers, supervisors, directors, production coordinators and shops managers coordinate the completion of the maintenance. This maintenance team typically works in three shifts a day, seven days a week, to complete the needed maintenance.

Brief Summary Text (8):
To minimize the number of days the aircraft is removed from operation, a maintenance plan must be developed to assign and monitor the completion of tasks. The development of such a plan is made more difficult by the identification of non-routine tasks during the maintenance, back orders on parts which preclude the completion of certain tasks and the failure to complete timely critical path tasks (those which prevent subsequent tasks from being completed). No computer-based method exists to dynamically prepare such a maintenance plan using dynamically changing information, such as available labor hours, sequence and dependency of tasks, and the addition of non-routine tasks.

Brief Summary Text (9):
Airlines can further save costs by escalating, when permissible, the intervals at which tasks are performed. Based upon reliability data collected by an airline during maintenance of their own aircrafts, the FAA may allow the airline to more favorably escalate tasks beyond the requirements of the MRB document (i.e, require the task to be performed at longer intervals). Thus, if a task to inspect a particular part is performed as required every six months, and the part is consistently (throughout the fleet) in good condition, the task may be escalated to one a year (or some other interval). Such escalations of tasks can significantly affect the time and cost of maintaining an airline's fleet of aircraft. A reliability program thus modifies, for a particular airline only, an aircraft's MRB document by changing the intervals required between overhauls, inspections and checks of aircraft equipment. Guidance on reliability program elements is listed in Advisory Circular (AC) 120-17, Maintenance Program Management Through Reliability Methods, as amended, the Airline/Manufacturer Maintenance Program Planning Document, MSG-2/3, and/or Maintenance Tasks.

Brief Summary Text (10):
A reliability program can further help airlines determine whether individual warrantied parts have met the manufacturer's predicted life limits. Often, manufacturers of aircraft parts, especially engine parts, guarantee that the part will not fail before a specified number of hours. Thus, a reliability program can enable airlines to get warranty money back from warranty administration on that part if the part does not meet the manufacturer's predicted life limits. There is no computer-based program for monitoring the reliability program of an entire fleet of aircraft as it relates to the requirements of the MRB document, which uses data dynamically collected during the process of maintenance.

Brief Summary Text (11):

Another aspect of an aircraft maintenance program for an airline is the proper training of its personnel. The FAA has very strict standards regarding the training required of aircraft mechanics. Before permitting a mechanic to perform a task, the FAA requires that the mechanic have been previously supervised doing the task or specifically trained for the task. The FAA additionally requires much of the training to be performed on a recurrent basis. Therefore, airlines must monitor and log all training received by its maintenance employees.

Brief Summary Text (12):
Airlines must also maintain a significant number of publications, such as the MRB document, training manuals, maintenance manuals, illustrated parts catalogs, structural repair manuals, aircraft wiring diagrams and a general engineering and maintenance manual. Presently, these documents are mostly maintained in paper format.

Brief Summary Text (13):
No system presently exists to integrate all of the above-listed facets of a successful aircraft maintenance program. Additionally, no system presently exists to dynamically manage an aircraft's MRB document, to dynamically monitor for the dates when tasks are due on an aircraft, to log the completion of tasks and corrective actions taken on an aircraft, to dynamically prepare a maintenance plan, to dynamically collect reliability data or to dynamically collect personnel training records. Accordingly, there is a need for a system and method for dynamically managing, in real-time, aircraft maintenance requirements.

Brief Summary Text (15):
The present invention is an aircraft maintenance tracking system for tracking aircraft maintenance required on an aircraft. The aircraft maintenance tracking system includes means for tracking accumulated usage data of the aircraft, means for receiving a list of routine tasks required to be performed on the aircraft, means for tracking task accomplishment data for each routine task, means for determining a maintenance due point for each routine task, means for identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated usage data of the aircraft is less than a user-defined critical value, and means for reporting maintenance due tasks.

Drawing Description Text (2):
FIG. 1 is a simplified block diagram of a system in accord with the present invention for dynamically managing, in real-time, aircraft maintenance requirements.

Drawing Description Text (7):
FIG. 8 is a flow diagram illustrating a preferred method of using a DAMP manager component of the system of FIG. 1 to complete a maintenance check of an aircraft.

Detailed Description Text (2):
FIG. 1 is a simplified block diagram of system 10 in accord with the present invention for dynamically managing, in real-time, aircraft maintenance requirements. System 10 interfaces with a plurality of aircraft, such as aircraft 12, corresponding aircraft maintenance requirements, such as aircraft maintenance requirements 14, personnel training records 16, FAA training requirements 18, and user preferences 20. System 10 is a multiple component system which includes Maintenance Review Board (MRB) program manager 22, aircraft tracking manager 24, Dynamic Aircraft Maintenance Production (DAMP) manager 26, reliability manager 28, electronic publications manager 30 and personnel training manager 32.

Detailed Description Text (3):
From aircraft maintenance requirements 14, MRB program manager 22 extracts maintenance tasks required for aircraft 12 and, for each task, time control points (or limits by which the task must be performed). MRB program manager uses this information to allow an airline operator to organize these tasks into logical groups which can be simultaneously performed. MRB program manager 22 provides the maintenance plan, along with the corresponding time control points, to aircraft tracking manager 24.

Detailed Description Text (5):
When aircraft 12 enters a heavy maintenance period, DAMP manager 26 allows airline operators to create a dynamic maintenance program for assigning and monitoring the

completion of tasks on aircraft 12.

Detailed Description Text (6):
Upon completion of a heavy maintenance period, reliability manager 28 records data relating to reliability of individual aircraft parts. The airline's reliability board may later use reliability manager 28 to query the reliability data and generate reports useful for recommending changes to the MRB program.

Detailed Description Text (7):
Electronic publications manager 30 is a tool which gathers the multitude of publications needed in the aircraft maintenance industry, and provides them in an on-line environment.

Detailed Description Text (9):
Although it is preferable that an airline maintenance program utilize each of the components included in system 10 of FIG. 1, those skilled in the art will recognize that each of the individual components may be used independently, collectively, or in combinations of the components. Thus, an airline may incorporate only MRB program manager 22 and DAMP manager 26 with its own existing legacy system for monitoring when tasks are due on an aircraft.

Detailed Description Text (11):
Aircraft maintenance requirements 14, which originate from the aircraft manufacturer, list the tasks that must be accomplished on aircraft 12 and the timescale for how often the tasks must be accomplished in order to keep aircraft 12 in airworthy condition. The Maintenance Review Board (MRB) collects this information. These requirements can be revised throughout the life of aircraft 12 by any of the aircraft manufacturer, the Federal Aviation Administration (FAA), the Maintenance Review Board (MRB) or the airline operator (with FAA approval). Aircraft maintenance requirements 14 may include information regarding routine tasks, customer-specific tasks, FAA Airworthiness Directives, Manufacturer's Service Bulletins and Letters, and other trackable tasks required for airline maintenance.

Detailed Description Text (14):
MRB program manager 22 takes aircraft maintenance requirements 14 and creates a maintenance program for aircraft 12. MRB program manager 22 allows an airline operator to organize all of the maintenance tasks into logical groups based on frequency, type, and an airline's operational/scheduling preferences 20. As a result, MRB program manager 22 provides a customized maintenance schedule that allows the airline to not only keep track of each maintenance task individually, but also carry out the maintenance tasks much more efficiently.

Detailed Description Text (15):
FIG. 2 is a flow diagram 40 of MRB program manager 22 of system 10 of FIG. 1. During its initial setup, which is step 42, MRB program manager 22 extracts from aircraft maintenance requirements 14, all of the tasks that must be performed on an aircraft of type aircraft 12, as well as the time control points (or limits by which the task must be performed) for each task.

Detailed Description Text (19):
MRB program manager 22 preferably provides both the master maintenance program and the airline-modified maintenance program, along with the corresponding time control points, to aircraft tracking manager 24.

Detailed Description Text (20):
FIG. 3 illustrates example graphical user interface (GUI) 50 used in conjunction with MRB program manager 22 of system 10. In the example of FIG. 3, the tasks of a test aircraft are organized into a plurality of checks including A checks 52. Other types of checks not illustrated in FIG. 3 are C checks, eight-year checks, flight cycle checks, and special checks. In GUI 50, column 54 lists the name of each check. Column 56 details the number of tasks included within each of the plurality of checks. Column 58 details the forecasted hours required to complete each task. Column 60 lists the form number of each task. Columns 62 list the time control points (or interval periods at which each of the plurality of checks is to be performed). The time control point may be listed as a specific number of flight hours, flight cycles or months. For each

of the plurality of checks, buttons are provided to allow an airline operator to revise the checks ("Revise" button in column 64), view the tasks within the check ("View" button in column 66), or generate a checklist of the tasks within the check ("Checklist" button in column 68).

Detailed Description Text (21):
FIG. 4 illustrates example graphical user interface (GUI) 80 used in conjunction with MRB program manager 22 of system 10. GUI 80 illustrates a partial listing of tasks 82 to be performed in conjunction with a selected one of A checks 52 of FIG. 3. Tasks 82 within selected A check 52 are organized by region of the aircraft, such as "upper fuselage above cabin floor" and "tailcone & empennage group". For each task 82 listed in GUI 80, column 84 provides a task number, column 86 provides a task description, column 88 provides the task's official MRB interval (or time control point), column 90 provides an approximation of the amount of time required to perform the task, column 92 provides the task type, and column 94 provides the zone in which the work is to be performed. Details of each task 82 can be revised by selecting the corresponding "Revise" button provided in column 96.

Detailed Description Text (23):
Aircraft Tracking Manager

Detailed Description Text (24):
Aircraft tracking manager 24 functions as an aircraft scheduling tool by keeping track of all maintenance activities accomplished on aircraft 12. Tracking manager 24 receives a maintenance program as an input from MRB program manager 22, tracks the amount of accumulated time for each maintenance task, and outputs tracking information in the form of a status report. If tracking manager 24 is used independently, the maintenance program is input from aircraft maintenance requirements 14.

Detailed Description Text (25):
FIG. 5 is a flow diagram 100 of tracking manager 24 of system 10. At step 102, tracking manager 24 receives the maintenance program. Preferably, MRB program manager 22 provides the master maintenance program, the airline-modified maintenance program, and corresponding time control points to aircraft tracking manager 24.

Detailed Description Text (27):
At step 106, tracking manager 24 keeps track of information such as how many flight cycles, flight hours and time aircraft 12 has accumulated. When integrated with MRB program manager 22, tracking manager 24 ensures that aircraft 12 is not flown through one of its maintenance limits. Tracking data may be automatically entered into tracking manager 24 by an automated system installed aboard aircraft 12 or manually by airline ground crews. Manually-entered data may be entered at the end of a day by maintenance crews performing the aircraft's daily line check. Tracking data may also be provided by dispatch employees who also monitor this information.

Detailed Description Text (28):
At step 108, tracking manager 24 receives and logs all maintenance activities accomplished on aircraft 12, thereby serving as a maintenance logbook for aircraft 12. In this capacity, tracking manager 24 stores such information about each discrete task accomplished on aircraft 12 as what was done, what was replaced, who did the work and when was the work done. To meet FAA requirements, the electronic logbook may be printed and stored in paper format. When, if ever, the FAA approves the electronic storage of aircraft maintenance logbooks, airlines will no longer need to store paper copies of its maintenance records.

Detailed Description Text (30):
Various status reports can be generated by users of tracking manager 24 by making inquires as to what tasks need to be completed within selected parameters. FIG. 6 illustrates example graphical user interface (GUI) 120 used in conjunction with tracking manager 24. The example of FIG. 6 is a partial status report for test aircraft 12. The status report lists a plurality of tasks 122, and includes information on each task, such as, the MRB document source numbers listed in column 124 and a task description listed in column 126. Column 128 details the flight hour, flight cycle and date at which task 122 was last completed. Column 130 lists the flight hour, flight cycle or date by which task 122 must be performed. Finally, column

132 provides a "Revise" button allowing an airline operator to revise the specifications of a particular task.

Detailed Description Text (31):
FIG. 7 illustrates example graphical user interface (GUI) 140 used in conjunction with tracking manager 24. GUI 140 is an example "Tasks Due" screen 140 of system 10. Screen 140 shows, in real-time, a list of tasks due within a user-specified range of dates, hours, or cycles. The user can enter a number of hours 142, a number of cycles 144, or a date 146, and click on button 148 ("Retrieve Records") to retrieve a list of tasks due within the entered range. The resulting screen lists the task descriptions 150, the date last completed 152 (as well as the flight hours and flight cycles accrued by that completion date), the time limits 154 (or time control point), and the time remaining 156 for each task. The time remaining column will preferably provide a graphical cue to the user as to which tasks are overdue, which are nearing their due date, and which are not yet due. Such a graphical cue could be color-coding the remaining time information. In the example of FIG. 7, cells could be colored red to signify overdue tasks (not shown), cells 158 could be colored yellow to signify task which will be due within the user-specified range, and cells 159 could be colored white to signify tasks which are not yet due and outside the user-specified range. As the tasks are completed, the historical record for each task is updated in real-time to the current status. Screen 140 assists the user in developing the best plan and work order for an aircraft to insure that tasks are completed in a timely manner.

Detailed Description Text (33):
Dynamic Aircraft Maintenance Production (DAMP) Manager

Detailed Description Text (34):
DAMP manager 26 creates a dynamic maintenance program for assigning and monitoring the completion of tasks on aircraft 12 in a heavy maintenance environment. DAMP manager 26 is designed for multiple users of a production coordination system. Briefly, DAMP manager 26 is a system which allows maintenance employees to quickly, and easily, know what routine and non-routine tasks they are scheduled to complete; provides mechanic crew leads the ability to dynamically assign tasks to mechanics and to query which tasks are currently assigned and to whom they are assigned; and provides maintenance employees and supervisors the ability to compare actual time expended to complete a maintenance check to forecasted time for the maintenance check.

Detailed Description Text (35):
In the heavy maintenance environment, each individual maintenance team member, from mechanic to top-tier management, has a specific job to complete. An ideal maintenance plan for an aircraft would take into account the knowledge and experience of all employees working to maintain the aircraft. DAMP manager 26, in a sense, allows each employee to contribute to the overall maintenance production plan. In the DAMP system, each employee is given the tools they need to do their job. Each employee has access to computer screens containing information relevant to the completion of their own job. In using the system, each employee enters information into the system in response to the computer screens presented to the employee. That information is processed by DAMP manager 26, with the end result being that the mechanics always know exactly what tasks on which to work. Additionally, DAMP manager 26 creates a history of events to enable production coordinators to identify what works and what does not work in the maintenance plan.

Detailed Description Text (36):
FIG. 8 is a flow diagram 160 illustrating a preferred method of using DAMP manager 26 to complete a heavy maintenance check of aircraft 10. Initially, at step 162, DAMP manager 26 extracts data from MRB program manager 22 and tracking manager 24 to identify the routine tasks that need to be performed on aircraft 10. If DAMP manager 26 were operated in a stand-alone environment, this data would be retrieved directly from aircraft maintenance requirements 14, which would be abstracted by the airline operator.

Detailed Description Text (37):
At step 164, DAMP manager 26 preferably sorts the tasks into aircraft zones in which those tasks pertain, such as nose, tail or west wing.

Detailed Description Text (38):
At step 166, DAMP manager 26 generates a proposed flow for the aircraft. This flow may further be broken down by zone. In creating a proposed flow, DAMP manager 26 considers whether the completion of certain tasks is essential for the completion others.

Detailed Description Text (43):
Also when signing out of DAMP manager 26, at step 176, mechanics enter any passdown notes or corrective actions taken during the performance of a task. Often, tasks left incomplete at the end of a shift are picked up by a mechanic on the next shift. Passdown notes enable those mechanics who continue working on the task to know what was completed by the previous mechanic. These notes do not remain part of the maintenance records, and are discarded once the task has been completed. Corrective action notes indicate what corrective actions were taken by a mechanic, and become part of the official maintenance logbook for the aircraft.

Detailed Description Text (45):
Often, while performing a routine task, the mechanics and inspectors will identify additional tasks that need to be accomplished to maintain the aircraft in an airworthy condition. At step 180, these non-routine tasks are entered into DAMP manager 26.

Detailed Description Text (46):
DAMP manager 26 constantly updates the overall completion time and tracks critical path jobs which will prevent subsequent jobs from being done. Thus, steps 164-180 are repeated until the maintenance check on the aircraft is complete.

Detailed Description Text (47):
An example implementation of DAMP manager 26 is illustrated in FIGS. 9-17. FIG. 9 illustrates example graphical user interface (GUI) 190 used in conjunction with DAMP manager 26. GUI 190 is an example status screen of system 10. Screen 190 shows in real-time the current maintenance status of aircraft 12. Section 192 of GUI 190 displays the tail number of aircraft 12 (US248 in this example) and user name (Melling). Section 192 also includes pull-down menus 194. Each pull-down menu 194 provides additional levels of access in DAMP manager 26. Thus, a crew member would be provided with only one pull-down menu, while senior management would be provided with several pull-down menus. In this example, user Melling is provided with five pull-down menus. In addition, section 192 includes button 196 ("Log Off") which allows the user to log off of DAMP manager 26.

Detailed Description Text (48):
Section 198 of GUI 190 is a line chart indicative of overall maintenance program progress with hours plotted vertically and days progressing horizontally. Time scale 200, which runs horizontally across section 198, chronologically displays the number of days in the check. Solid horizontal line 202, which is located immediately below time scale 200, represents the currently estimated number of hours required to complete the aircraft maintenance check. Estimate 204, which is displayed beneath solid horizontal line 202, provides a numeric representation of the total number of hours currently estimated to complete the check. Solid horizontal line 206 represents the projected number of hours required to complete the aircraft maintenance check, while forecast 208, which is displayed beneath solid horizontal line 204, provides a numeric representation of the total number of hours projected to complete the check. First broken line 210 represents the planned available labor for the check (as it accrues each day), while second broken line 212 represents the actual labor expended each day on the check. Lines 210 and 212 can be color coded to allow easy differentiation by the airline operator.

Detailed Description Text (51):
Section 220 of GUI 190 is a bar graph indicative of the real-time progress in individual cells (or zones) of aircraft 12. For each cell, the bars graphically illustrates the forecast of when the maintenance check of aircraft 12 will be complete. For example, in cell 1 (the wings zone), bar 222 indicates the number of labor hours that have been applied against that cell, the total bar (formed of bar 222 and bar 224) indicates the total number of hours that have been estimated in that cell, and the number following the total bar indicates the percentage complete of that zone (27% in this example). Similar section 226 (not fully shown) displays a bar graph indicative of the real-time progress by skill type and the total number of mechanics

available by skill.

Detailed Description Text (53):
As in FIG. 9, section 234 of GUI 230 displays the tail number of aircraft 12 (US248)and user name (Melling). Section 234 also includes pull-down menus 236. In addition, section 234 includes button 238 ("Log Off") which allows the user to log off of DAMP manager 26.

Detailed Description Text (54):
Flow chart 232 shows, in real-time, a list of all tasks that are required to be completed during the maintenance check of aircraft 12. Time scale 240 chronologically displays the number of days in the check. In flow chart 232, a width of task bar 242 indicates the time duration of a specific task, while the location of task bar 242 indicates its placement in the overall schedule. As flow chart 232 is dynamically updated, completed tasks will be represented by their actual duration and placement, while incomplete tasks will be represented by their planned duration and placement.

Detailed Description Text (57):
FIG. 11a illustrates example graphical user interface (GUI) 250 used in conjunction with DAMP manager 26. GUI 250 is an example crew assignment screen listing tasks assigned to a specific crew working on aircraft 12. Again, section 252 displays information about aircraft 12 and the user, as well as pull-down menus and a log off button. In this example, user "Roche" has access to only two pull-down menus (compared with five in FIG. 9), indicating that user "Roche" has less access to DAMP manager 26 than user "Melling" of FIG. 9.

Detailed Description Text (62):
FIG. 11b illustrates example graphical user interface (GUI) 270 used in conjunction with DAMP manager 26 of system 10. GUI 270 is an example crew member assignment screen listing tasks currently assigned to a specific crew member working on aircraft 12. Again, section 272 displays information about aircraft 12 and the user, as well as pull-down menus and a log off button. In this example, user "Albin" (crew member from FIG. 11a) has access to two pull-down menus.

Detailed Description Text (66):
GUI 280 presents the following information about the selected task: aircraft tail number 282, task number 284, bar code 286 corresponding to task number 284, work order number 288, zone number 290, sequence number 292, estimated hours 294, actual hours accrued 296, suggested number of crew members 298, skill required 300, crew numbers 302 of crews assigned to task, current date 304, station number 306, and discrepancy or task description 308.

Detailed Description Text (70):
GUI 320 presents the following information about a selected task: task card number 322, work order number 324, aircraft tail number 326, aircraft serial number 328, accrued flight hours 330, accrued cycles 332, and date 334. GUI 320 also presents a series of steps 336 which provide instructions on how the task is to be performed. In the example illustrated, there are two steps (A and B), with step B having two sub-steps (1 and 2). Columns 338 and 339 indicate what skill types should perform each step. GUI 320 is configured according to the standards of the airline operator for which DAMP manager 26 is designed.

Detailed Description Text (74):
Section 376 of GUI 340 visually indicates (preferably by a color-coded dot 378 or an arrow) the location on aircraft 12 where the selected task is targeted. Photograph 384 of the task location is also provided. GUI 340 also indicates, in real-time, where this task falls in the overall production plan. Combined, bar graph 380 and indicator mark 382 represent the current priority of the selected task in relation to all the other maintenance tasks within the check. The priority of the task can be increased by sliding indicator mark 382 toward the top of bar graph 380. Conversely, the priority of the task can be decreased by sliding indicator mark 382 toward the bottom of bar graph 380. A similar bar graph and indicator mark can also be provided to indicate where in the current overall status of the maintenance check the task lies.

Detailed Description Text (75):

FIG. 15 illustrates example graphical user interface (GUI) 390 used in conjunction with DAMP manager 26 of system 10. GUI 390 is an example work locations screen of system 10. GUI 390 presents a graphical image of aircraft 12 (from three different perspectives) and dots to identify where on aircraft 12 maintenance needs to be performed. As a user moves the cursor over selected dot 392, a roll-over description of the maintenance task can be provided. The user can click on dot 392 to access the work card screen for that particular maintenance task.

Detailed Description Text (77):
FIG. 17 illustrates example graphical user interface (GUI) 410 used in conjunction with DAMP manager 26 of system 10. GUI 410 is an example "Task Re-Evaluation" shift end screen. Section 412 displays information about aircraft 12 and the user, as well as pull-down menus and a log off button.

Detailed Description Text (81):
Upon completion of a heavy maintenance period, reliability manager 28 records data relating to reliability of individual aircraft parts. The airline's reliability board may later use reliability manager 28 to query the reliability data and generate reports useful for recommending changes to the MRB program.

Detailed Description Text (84):
The primary purpose of an MRB document is to assist the regulatory authorities in determining the initial scheduled maintenance requirements for new or derivative types of transport-category aircraft. The MRB document is used as the basis from which an airline develops its own continuous airworthiness maintenance program. Any change to the maintenance program requires an analysis phase and an appropriate sampling of aircraft reliability data. The resulting information serves as justification for any modifications to the airline's maintenance program.

Detailed Description Text (85):
A reliability program establishes the time limitations or standards for determining intervals between overhauls, inspections and checks of aircraft equipment. Guidance on reliability program elements is listed in Advisory Circular (AC) 120-17, Maintenance Program Management Through Reliability methods, as amended, the Airline/Manufacturer Maintenance Program Planning Document, MSG-2/3, and/or Maintenance Tasks. A reliability program typically collects reliability data from sources including unscheduled removals of parts, confirmed failures of parts, pilot reports, sampling inspections, shop findings, functional checks, bench checks, service difficulty reports, mechanical interruption summaries and other sources the airline considers appropriate.

Detailed Description Text (87):
Electronic publications manager 30 is a tool which gathers the multitude of publications needed in the aircraft maintenance industry, and provides them in an on-line environment.

Detailed Description Text (88):
The airline maintenance industry is a highly regulated industry which produces a substantial number of disparate publications essential for operation of an airline maintenance facility. Electronic publications manager 30 is a tool that gathers this multitude of publications into an electronic form, thus making the publications more easily accessible to aircraft maintenance personnel.

Detailed Description Text (90):
Electronic publications manager 30 stores such publications as training manuals, maintenance manuals, illustrated parts catalogs, structural repair manuals, aircraft wiring diagram manuals, FAA directives and an airline's specific general engineering and maintenance manual.

Detailed Description Text (97):
In addition, personnel training manager 32 compares personnel training records 16 with FAA training requirements 18 to monitor which tasks each employee is qualified to perform. By integrating personnel training manager 32 with DAMP manager 26, crew leads can quickly ascertain which mechanics have the training necessary to perform specific tasks, thereby ensuring that only qualified mechanics are assigned to tasks. The FAA

has very strict standards regarding the training required of aircraft mechanics. Before a mechanic can independently perform a task, the FAA requires that the mechanic have either been previously supervised performing the task or been specifically trained for that task.

Detailed Description Text (99):
Additionally, as employees are scheduled off the floor for training, DAMP manager 26 instantaneously makes adjustments to the number of employee hours available to complete maintenance of an aircraft. Thus, the production coordinator can immediately ascertain the effect of removing those employees from the work floor, and will be able to plan the maintenance production accordingly. If the production schedule is negatively affected by the training (i.e., one or more days are added to the production schedule), the production planner may schedule some personnel to work overtime or shift personnel in from other maintenance bays to make up the missing production hours. A production coordinator may also consult with training personnel to reschedule the training to minimize harm to the production schedule (e.g., perhaps only six of twelve employees scheduled for training will actually attend the training). Effectively, the management team is given early options to control its production schedule.

Detailed Description Text (102):
FIG. 18 is a flow diagram of the automatic task assignment component of DAMP manager 26. At step 332, the auto-assign system receives a prioritized list of tasks to be accomplished in one to two days, and at step 334, the auto-assign system receives personnel training data from personnel training manager 32. At step 336, the auto-assign system compares the available resources to the need resources to timely complete the maintenance check. If there is enough time and enough mechanics to enable the completion of all necessary tasks within the necessary time period, the auto-assign system will enter a training mode. In this training mode, at step 338, DAMP manager 26 will assign to specific tasks, when possible, those mechanics who need on the job training along with a mechanic who has the necessary training. To enable this automatic training function, DAMP manager 26 analyzes the maintenance flow of the aircraft, how much maintenance time is remaining, how many tasks need to be accomplished, how many mechanics are scheduled to work and personnel training records 16.

Detailed Description Text (105):
According to the present invention, a system and method are provided for dynamically managing, in real-time, aircraft maintenance requirements. The system and method of the present invention brings a distributed computing framework of using client/server and Internet technologies to the field of aircraft maintenance, allowing end-users to react quickly to the dynamics of everyday events. The system and method of the present invention take advantage of a process of using the Internet browser technology to deliver real-time distributed software products for the aircraft maintenance industry.

Detailed Description Text (107):
The airline industry is formed of four tiers of airline operators: the major airlines, the regional airlines, the corporate owners of small fleets of aircraft and the individual (or private) owners of aircraft. Each of these tiers of operators has need for some-scaled version of system 10 of the present invention. Certainly, an individual owner of a single aircraft will have different needs that a multiple-hubbed major aircraft operator of a large fleet of aircraft. Nonetheless, each of the above-described components of system 10 has applicability to each tier of aircraft operators.

Detailed Description Text (109):
Major airlines typically operate a large and varying fleet of passenger aircraft. These operators generally fly into a large number of cities, with maintenance potentially occurring in any of those cities, and heavy maintenance bases in several of those cities. The major airlines stand to lose a substantial amount of revenue each day one of its aircraft is grounded due to maintenance. Therefore, one of the main priorities for the major airline is to minimize the number of days that its aircraft remain in heavy maintenance (without sacrificing the airworthiness of the aircraft) by efficiently managing the completion of tasks during heavy maintenance periods. For

that reason, DAMP manager 26 is likely the most important component of a major airline's maintenance management program. Similarly, personnel training manager 32 aids the airline in ensuring that their maintenance personnel are training

Detailed Description Text (111):
Regional airlines will typically operate a much smaller fleet of aircraft than the major airlines, with less variety in the type of aircraft. Additionally, the aircraft owned by the regional airlines tend to be smaller than those owned by the major airlines, and tend to require fewer maintenance tasks to keep them airworthy. Because of the smaller scale of the regional airlines, they do not have the same manpower and resources of the major airlines to create individualized maintenance programs. Thus, the regional airlines tend to be more concerned with simply gathering all of the information about their maintenance program in one place. For that reason, MRB program manager 22 and tracking manager 24 are likely the most important components of a regional airline's maintenance management program. MRB program manager 22 and tracking manager 24 will provide the regional airlines with the tools needed to organize their maintenance tasks into logical groupings, and to monitor those tasks for when they are due.

Detailed Description Text (114):
Corporate and general aviation aircraft operators typically own one to five aircraft. Often, the aircraft owned by corporate and individual operators do not have MRB maintenance documents associated with them, but only a maintenance manual supplied by the aircraft manufacturer. In lieu of an MRB maintenance document, the tasks and suggested performance intervals listed in the maintenance manual can loaded into MRB program manager 22 to create a well-organized maintenance program, and into tracking manager 24 to track the tasks listed in the maintenance manual.

Detailed Description Text (116):
The system and method of the present invention is a software system designed for the multiple users of a production coordination system within the aircraft maintenance industry. It allows mechanics to understand exactly what routine and non-routine items they are to work on, it allows the crew leads to assign tasks to crew members and query as to what tasks are currently being worked on and by whom, and it provides the managers the opportunity to compare actual time expended on aircraft compared to forecasted time and to adjust crew priorities in real-time. Crew leads, managers and executive management can quickly evaluate where the aircraft is in relation to the forecasted time of the aircraft check as to percentage complete and estimated time of completion visually by the use of easy to-understand charts.

CLAIMS:

1. An aircraft maintenance tracking system for tracking aircraft maintenance required on an aircraft, the aircraft maintenance tracking system comprising:

means for tracking accumulated usage data of the aircraft;

means for receiving a list of routine tasks required to be performed on the aircraft, each routine task having a control point which defines an interval at which the routine task is to be performed;

means for identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated usage data of the aircraft is less than a user-defined critical value; and

2. An aircraft maintenance tracking system for tracking aircraft maintenance required on an aircraft, the aircraft maintenance tracking system comprising:

means for tracking accumulated usage data of the aircraft, wherein the accumulated usage data includes a number of accumulated flight hours and a number of accumulated flight cycles of the aircraft, as well as a current date;

means for receiving a list of routine tasks required to be performed on the aircraft, each routine task having a control point which defines an interval at which the routine task is to be performed;

means for identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated usage data of the aircraft is less than a user-defined critical value; and

3. An aircraft maintenance tracking system for tracking aircraft maintenance required on an aircraft, the aircraft maintenance tracking system comprising:

means for tracking accumulated usage data of the aircraft;

means for receiving a list of routine tasks required to be performed on the aircraft, each routine task having a control point which defines an interval at which the routine task is to be performed, wherein the list of routine tasks is derived from a Maintenance Review Board document for the aircraft;

means for identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated usage data of the aircraft is less than a user-defined critical value; and

4. An aircraft maintenance tracking system for tracking aircraft maintenance required on an aircraft, the aircraft maintenance tracking system comprising:

means for tracking accumulated usage data of the aircraft;

means for receiving a list of routine tasks required to be performed on the aircraft, each routine task having a control point which defines an interval at which the routine task is to be performed, wherein the list of routine tasks comprises Maintenance Review Board tasks and maintenance task groups, wherein the Maintenance Review Board tasks are derived from a Maintenance Review Board document for the aircraft and the maintenance task groups are groupings of Maintenance Review Board tasks;

means for identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated usage data of the aircraft is less than a user-defined critical value; and

5. An aircraft maintenance tracking system for tracking aircraft maintenance required on an aircraft, the aircraft maintenance tracking system comprising:

means for tracking accumulated usage data of the aircraft;

means for receiving a list of routine tasks required to be performed on the aircraft, each routine task having a control point which defines an interval at which the routine task is to be performed;

means for tracking task accomplishment data for each routine task, wherein task accomplishment data includes a maintenance date on which the routine task was completed, as well as a number of flight hours and flight cycles accumulated on the aircraft by the maintenance date;

means for identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated usage data of the aircraft is less than a user-defined critical value; and

6. An aircraft maintenance tracking system for tracking aircraft maintenance required on an aircraft, the aircraft maintenance tracking system comprising:

means for tracking accumulated usage data of the aircraft;

means for receiving a list of routine tasks required to be performed on the aircraft, each routine task having a control point which defines an interval at which the routine task is to be performed;

means for identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated

usage data of the aircraft is less than a user-defined critical value;

means for receiving a list of non-routine tasks required to be performed on the aircraft, each non-routine task having a maintenance due point by which the non-routine task must be performed;

means for identifying non-routine maintenance due tasks as those non-routine tasks for which a difference between the maintenance due point of the non-routine task and the accumulated usage data of the aircraft is less than a user-defined critical value; and

7. An aircraft maintenance tracking system for tracking aircraft maintenance required on an aircraft, the aircraft maintenance tracking system being implemented over a communication medium operably connected to a plurality of input/output devices each having means for inputting and outputting information, the aircraft maintenance tracking system comprising:

means for tracking accumulated usage data of the aircraft;

means for receiving a list of routine tasks required to be performed on the aircraft, each routine task having a control point which defines an interval at which the routine task is to be performed;

means for identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated usage data of the aircraft is less than a user-defined critical value; and

8. The aircraft maintenance tracking system of claim 7 wherein the communication medium is a digital communications network.

9. A method for tracking aircraft maintenance required on an aircraft, the method comprising:

tracking accumulated usage data of the aircraft;

receiving a list of routine tasks required to be performed on the aircraft, each routine task having a control point which defines an interval at which the routine task is to be performed;

identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated usage data of the aircraft is less than a user-defined critical value; and

10. A method for tracking aircraft maintenance required on an aircraft, the method comprising:

tracking accumulated usage data of the aircraft, wherein the accumulated usage data includes a number of accumulated flight hours and a number of accumulated flight cycles of the aircraft, as well as a current date;

receiving a list of routine tasks required to be performed on the aircraft, each routine task having a control point which defines an interval at which the routine task is to be performed;

identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated usage data of the aircraft is less than a user-defined critical value; and

11. A method for tracking aircraft maintenance required on an aircraft, the method comprising:

tracking accumulated usage data of the aircraft;

receiving a list of routine tasks required to be performed on the aircraft, each routine task having a control point which defines an interval at which the routine

task is to be performed, wherein the list of routine tasks is derived from a Maintenance Review Board document for the aircraft;

identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated usage data of the aircraft is less than a user-defined critical value; and

12. A method for tracking aircraft maintenance required on an aircraft, the method comprising:

tracking accumulated usage data of the aircraft;

receiving a list of routine tasks required to be performed on the aircraft, each routine task having a control point which defines an interval at which the routine task is to be performed, wherein the list of routine tasks comprises Maintenance Review Board tasks and maintenance task groups, wherein the Maintenance Review Board tasks are derived from a Maintenance Review Board document for the aircraft and the maintenance task groups are groupings of Maintenance Review Board tasks;

identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated usage data of the aircraft is less than a user-defined critical value; and

13. A method for tracking aircraft maintenance required on an aircraft, the method comprising:

tracking accumulated usage data of the aircraft;

receiving a list of routine tasks required to be performed on the aircraft, each routine task having a control point which defines an interval at which the routine task is to be performed;

tracking task accomplishment data for each routine task, wherein task accomplishment data includes a maintenance date on which the routine task was completed, as well as a number of flight hours and flight cycles accumulated on the aircraft by the maintenance date;

identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated usage data of the aircraft is less than a user-defined critical value; and

14. A method for tracking aircraft maintenance required on an aircraft, the method comprising:

tracking accumulated usage data of the aircraft;

receiving a list of routine tasks required to be performed on the aircraft, each routine task having a control point which defines an interval at which the routine task is to be performed;

identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated usage data of the aircraft is less than a user-defined critical value;

receiving a list of non-routine tasks required to be performed on the aircraft, each non-routine task having a maintenance due point by which the non-routine task must be performed;

identifying non-routine maintenance due tasks as those non-routine tasks for which a difference between the maintenance due point of the non-routine task and the accumulated usage data of the aircraft is less than a user-defined critical value; and

15. A method for tracking aircraft maintenance required on an aircraft, the method being operable over a communication medium operably connected to a plurality of

input/output devices each having means for inputting and outputting information, the method comprising:

tracking accumulated usage data of the aircraft;

receiving a list of routine tasks required to be performed on the aircraft, each routine task having a control point which defines an interval at which the routine task is to be performed;

identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated usage data of the aircraft is less than a user-defined critical value; and

17. An aircraft maintenance tracking system for tracking aircraft maintenance required for a fleet of aircraft, the system comprising:

means for tracking accumulated aircraft usage data for each aircraft in the fleet of aircraft;

means for receiving, for each aircraft in the fleet of aircraft, a list of routine tasks required to be performed on the aircraft, each routine task having a control point which defines an interval at which the routine task must be performed;

means for identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated usage data of the aircraft is less than a user-defined critical value; and

18. An aircraft maintenance tracking system for tracking aircraft maintenance required for a fleet of aircraft, the system comprising:

means for tracking accumulated aircraft usage data for each aircraft in the fleet of aircraft;

means for receiving, for each aircraft in the fleet of aircraft, a list of routine tasks required to be performed on the aircraft, each routine task having a control point which defines an interval at which the routine task must be performed;

means for identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated usage data of the aircraft is less than a user-defined critical value;

means for receiving, for each aircraft in the fleet of aircraft, a list of non-routine tasks required to be performed on the aircraft, each non-routine task having a maintenance due date by which the non-routine task must be performed;

means for identifying non-routine maintenance due tasks as those non-routine tasks for which a difference between the maintenance due point of the non-routine task and the accumulated usage data of the aircraft is less than a user-defined critical value; and

19. An aircraft maintenance tracking system for tracking aircraft maintenance required for a fleet of aircraft, the aircraft maintenance tracking system being implemented over a communication medium operably connected to a plurality of input/output devices each having means for inputting and outputting information, the system comprising:

means for tracking accumulated aircraft usage data for each aircraft in the fleet of aircraft;

means for receiving, for each aircraft in the fleet of aircraft, a list of routine tasks required to be performed on the aircraft, each routine task having a control point which defines an interval at which the routine task must be performed;

means for identifying maintenance due tasks as those routine tasks for which a difference between the maintenance due point of the routine task and the accumulated usage data of the aircraft is less than a user-defined critical value; and

20. The aircraft maintenance tracking system of claim 19 wherein the communication medium is a digital communication network.